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RHINOLOGY

# Pleasantness of olfactory and trigeminal stimulants in different Italian regions

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**Abstract** Although individuals categorize odors according to their pleasantness, experience may also influence odor perception—a phenomenon that partially explains why different populations perceive odors differently. Italy, which comprises 20 regions, is characterized by very different cultures. In the present study, we investigated for the first time how Italian regional differences can affect odor perception. 254 healthy volunteers coming from northern, central, southern Italy, and Sicily, one of the two major Italian islands, were recruited in Padua, Rome, Naples, and Syracuse, respectively. Olfactory function was tested with Sniffin' Sticks identification subtest. Subjects who had a score in the range within the mean identification value ± 1 SD, in accordance with the age classes identified in the literature, were asked to judge the odor pleasantness of 20 substances. The hedonic tone of the odorants was categorized as pleasant, neutral, unpleasant, and very unpleasant. Some odorants were appreciated more in northern Italy than in the other parts of the country, whereas others were appreciated more in the south and in Sicily than in the north. Unpleasant odorants were judged less unpleasant in central Italy. Some odorants such as strawberry and vanilla were perceived similarly in all the regional areas. Our study indicates that in Italy, hedonic perception of odorants differs probably in relation with genetic, cultural, and environmental factors. Further investigation is needed to delve deeper into the factors that influence the quality odor perception amongst humans.

**Keywords** Smell · Hedonism · Italy · Regional areas · Odors

## Introduction

Olfaction plays a pivotal role in people's daily lives. Most natural odors are complex mixtures of many different volatiles. This means that the olfactory system is in contact with a great variety of molecules. Among the different cognitive abilities related to olfaction is learning. In effect, learning enables individuals of a given species to acquire and make use of the most appropriate information in a particular environment. An increasing number of studies suggest that learning plays a significant role in odor perception [1]. Interestingly, contextual odors, which are believed to be encoded in episodic memory along with an event and with the emotions experienced at the time of the event, can trigger people's memories of the past experiences, including emotional ones. The power of odors to evoke memories and associations and the effect of experience on odor pleasantness have been well documented [2]. For instance, one study suggested that individuals involuntarily categorize odors according to their pleasantness [3]. Similarly, a more recent study, which focused on verbal reports of the basic emotions triggered by olfactory inputs, concluded that olfactory stimuli can verbally elicit only a limited number of emotions, i.e., happiness, anxiety, and disgust [4].

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The theory that cultural experience can strongly influence the way people perceive odors has also been highly appreciated. In a Japanese–German cross-cultural study, clear differences in odor perception ratings were found between the two populations. For instance, a general positive association was found between odor pleasantness and edibility, thereby suggesting that culture-specific experiences, like food, can sway the way people perceive odors [5]. Moreover, regional factors also appear to modulate olfactory performances, including odor memory and odor pleasantness [6]. Hence, besides olfactory receptor genetic variations between individuals, which contributes to individual differences in smell perception [7], environmental factors such as learning and cultural experience do play an important role in modulating olfactory performance across regions.

Italy, a country of 20 regions, embraces a kaleidoscopic environment within its national boundaries and is highly renowned for its great variety of regional dishes, wines, and dairy products. Such diversity stems from the contextual presence of different natural ingredients and cultural influences, i.e., Balkan and Oriental in the south vs European Continental in the north and more specifically Italian in the center. Therefore, despite the inevitable inter-regional migration flows occurring mainly throughout the second half of the 20th century and the powerful impact of culinary and aesthetic mass culture on cultural diversity, nowadays, one can still perceive great trans-regional differences regarding the Italian preference for various culinary, household, and personal hygiene products. Furthermore, different genetic backgrounds are thought to exist between the various peninsular areas [8]. So far, no studies have yet addressed whether the kaleidoscopic nature of the Italian culture can lead to differences in odor perception.

In the present pilot study, we thus investigated for the first time the correlation between regional differences and odor pleasantness. To this aim, we recruited 254 healthy participants from northern, central, southerner Italy, and the island of Sicily. All participants were exposed to 20 different odorants and asked to categorize them as pleasant, neutral, unpleasant, or very pleasant.

## Materials and methods

Three hundred twenty-eight healthy subjects (191 females and 137 males, mean age 36 ± 14 years) were prospectively recruited. Of these, 34 females and 40 males were excluded, because they were affected by olfactory dysfunction (Sniffin' Sticks Identification subtest score <12 [9]) or had previously undergone nose and paranasal sinus surgery. Other exclusion criteria included smoking habit, nasal blockage, and chronic asthma. Eventually, 254 healthy volunteers (157 female and 97 males and mean age 33.9 ± 12 years) resulted eligible for the study. To investigated potential differences in the Italian regional areas (north, center, south, and islands), individuals were recruited in Padua for northern Italy, Rome for central Italy, Naples for southern Italy, and Syracuse (Sicily) for the two major islands. All considered volunteers have been living in their regional area for at least the last 20 years. The study was conducted in accordance with the 1996 Helsinki Declaration and was approved by the Internal Committees of the involved ENT sections. Informed consent was obtained from all subjects before evaluation.

Olfaction function was assessed with the Sniffin' Sticks Identification subtest. In brief, 16 odorants and a list of 4 descriptors were presented to each person, as previously described [9]. Subjects with a score in the range within the mean identification value ±1 SD, in accordance with age subclasses, were considered normosmic [9] and tested for odor pleasantness. Olfactory testing was performed in a quiet room with adequate ventilation. In addition, a subjective assessment of smell was recorded (normosmia, hyposmia, or anosmia).

For the evaluation of odor pleasantness, a test developed by the Department of Analytical Chemistry of the Faculty of Chemical Technology, University of Pardubice was used. Odorants were presented in commercially available felt-tip pens (ART.2739; Centropen a.s., Dacice, Czech Republic). Instead of a liquid dye, the cylinder was filled with odorants (Lachema a.s, Neratovice, Czech Republic or by SG spol. s.r.o., Zlin, Czech Republic). In total, 20 pens were filled with 2 ml of various substances as previously described (Table 1) [10].

Participants were exposed to n-butanol on two occasions: immediately after almond (*n*-butanol-1) and again after men's perfume (*n*-butanol-2), at different concentrations (see Table 1). The open-end of each felt-tip pen was placed 2 cm in front of both nostrils for 4 s. The participants were asked to categorize the hedonic tone of the odorant into four classes: pleasant, neutral, unpleasant, and very unpleasant. After approximately 15 s, they were presented with another odorant.

### Statistical analysis

The Kruskal–Wallis test was applied to establish which odorants elicited a statistically different perception in the four regional areas. The test, which is a non-parametric version of ANOVA, can be applied to continuous and ordinal variables (as in the considered case). To apply the test to odor pleasantness, data were transformed into midranks, that is, the average ranks that would be assigned to a category if they were ranked without ties.

Once the statistically different odorants were defined, Dunn's test [11] was used to perform pairwise comparison. For each comparison, the null hypothesis was that the

**Table 1** Order of presentation, names, and concentrations of the tested odorants

| No. | Odorant | Manufacturer | Dilution |
|---|---|---|---|
| 1 | Rum | Aroo S.R.O. | No |
| 2 | Pineapple | Aroo S.R.O. | No |
| 3 | Fish composition | Aroma A.S. | No |
| 4 | Almond | Dr.Oetker (Brasil) | No |
| 5 | *N*-Butanol (1) | Faculty of Chemical Technology | Water 1:25 |
| 6 | Lemon | Aroo S.R.O. | No |
| 7 | Sour cherry | Aroo S.R.O. | No |
| 8 | Valeric acid | Basf | Water 1:100 |
| 9 | Coconut | Kovandovi | No |
| 10 | Water | Faculty of Chemical Technology | No |
| 11 | Vanilla | Aroo S.R.O. | No |
| 12 | Diesel fuel | Omv | No |
| 13 | Woman parfume | Avon | No |
| 14 | Acetic acid | Faculty of Chemical Technology | Water 1:4 |
| 15 | Deer | Aroma A.S. | No |
| 16 | Caproic acid | Reachim | Water 1:4 |
| 17 | Men parfume | No Ii | No |
| 18 | *N*-Butanol (2) | Faculty of Chemical Technology | Water 1:5 |
| 19 | Siberian musk deer | Aroma A.S. | No |
| 20 | Strawberry | Aroo S.R.O. | No |

probability of observing a randomly selected value from the first group that was larger than a randomly selected value from the second group equaled to one half. The null hypothesis corresponded to that of the Wilcoxon–Mann–Whitney rank-sum test and can be viewed as a test of the differences in the median of the distribution.

Hochberg correction [12] was used to account for multiplicity: $p$ values were sorted in increasing order and then individually replaced by max (1, $p$ value * $i$), where $i$ was the index of the ordering.

To establish the association between the different odorants, Spearman's coefficient was calculated for each pair of odorants.

## Results

Of the 254 normosmic volunteers, 21 reported a decreased sense of smell when subjected to the subjective assessment of smell. The mean value of the Sniffin' Sticks Identification subtest was 13.6 ± 1.2 (range 12–16). The main results are shown in Tables 2, 3, and 4. In particular, Table 2 shows the inter-regional hedonic tone differences of the odors tested, whilst Table 3 shows the identification percentages in different regions of the Sniffin' sticks identification items (lemon, fish, and ananas) included in the subjective ratings. Finally,

**Table 2** Inter-regional hedonic tone differences $p$ values of the tested odors

| No. | Odorant | North vs Center | North vs South | North vs Sicily | Center vs South | Center vs Sicily | South vs Sicily |
|---|---|---|---|---|---|---|---|
| 1 | Rum | **0.000** | **0.023** | **0** | **0.022** | 0.36 | **0.042** |
| 2 | Pineapple | 0.21 | **0.001** | **0.007** | 0.11 | 0.13 | 0.47 |
| 3 | Almond | **0.000** | **0.000** | **0.000** | 0.14 | 0.32 | 0.07 |
| 4 | *N*-Butanol (1) | **0.000** | 0.11 | 0.23 | **0.03** | **0.01** | 0.40 |
| 5 | Lemon | 1.000 | 1.000 | 0.50 | 1.000 | 1.000 | 0.77 |
| 6 | Sour cherry | **0.01** | 0.2 | **0.001** | 0.13 | 0.20 | **0.02** |
| 7 | Valeric acid | **0.001** | **0.02** | 0.49 | 0.16 | **0.003** | **0.03** |
| 8 | Fish Composition | **0.001** | 0.22 | 0.14 | **0.014** | **0.006** | 0.25 |
| 9 | Coconut | 0.51 | 0.51 | 0.48 | 0.08 | 0.40 | 0.45 |
| 10 | Water | 0.49 | 0.23 | 0.71 | 0.25 | 0.75 | 0.35 |
| 11 | Vanilla | 0.48 | 0.73 | 1.000 | 1.000 | 1.000 | 0.79 |
| 12 | Diesel fuel | 0.60 | 0.46 | 0.12 | 0.42 | 0.48 | 0.31 |
| 13 | Woman parfume | 0.49 | 0.50 | 0.76 | 0.48 | 0.30 | 0.12 |
| 14 | Acetic acid | **0.006** | **0.000** | 0.45 | 0.64 | **0.012** | **0.002** |
| 15 | Deer | 0.67 | **0.002** | 0.61 | 0.07 | 0.41 | 0.06 |
| 16 | Caproic acid | **0.000** | **0.000** | 0.24 | **0.002** | **0.000** | **0.002** |
| 17 | Men parfume | 0.49 | 0.14 | 0.69 | 0.15 | 0.45 | 0.65 |
| 18 | *N*-Butanol (2) | 1.000 | 1.000 | 1.000 | 1.000 | 0.89 | 0.45 |
| 19 | Siberian musk deer | 0.13 | 0.13 | 0.05 | 0.43 | 0.56 | 0.63 |
| 20 | Strawberry | 0.12 | 0.51 | 0.63 | 0.40 | 0.45 | 0.41 |

$p$: Kruskal–Wallis test

Significant $p$ values are reported in bold

**Table 3** Identification percentages in different regions of the Sniffin' sticks items included in subjective ratings

| | North (%) | Center (%) | South (%) | Sicily (%) |
|---|---|---|---|---|
| Lemon | 44.8 | 83.3 | 51 | 91.7 |
| Fish | 98.5 | 100 | 99 | 97 |
| Pineapple | 71.6 | 73.8 | 87.8 | 79 |

**Table 4** Sniffin' sticks identification subtest mean and SD scores in different Italian regions

| | North | Center | South | Sicily |
|---|---|---|---|---|
| Mean | 13.7 | 13.8 | 13.7 | 13.9 |
| SD | 1.04 | 1.2 | 1.2 | 1.1 |

*SD* standard deviation

Table 4 shows the mean Sniffin' Sticks Identification subtest value in the different Italian regions.

Considering the hedonic tone in the study population, we found inter-regional differences. In particular, of the 20 odorants tested, about 12 showed a different hedonic tone from one region to another (Fig. 1). For example, rum was clearly more appreciated in the north than in the other regional areas, whereas pineapple was more appreciated and identified in the south and Sicily than in the northern area. Similarly, almond and sour cherry were more appreciated in the northern Italy. Considering the odorants that are generally judged as unpleasant, we found differences across all regional areas. In general, caproic acid, fish composition, *n*-butanol-1, valeric acid, and acetic acid were judged less unpleasant in central Italy than in the other parts of the country.

Associations among the different tested odorants in the whole Italian sample (without regional differences) are shown in Fig. 2. The highest association was between rum and almond odorants ($r = 0.36$), followed by caproic acid and valeric acid ($r = 0.29$), and caproic acid and acetic acid ($r = 0.26$). Caproic acid was also associated with *n*-butanol-1 ($r = 0.24$) and fish composition ($r = 0.21$). An association between deer and diesel fuel odor ($r = 0.26$) was also observed. Finally, there was an association between lemon and women's perfume ($r = 0.27$) and between women's and men's perfumes ($r = 0.22$).

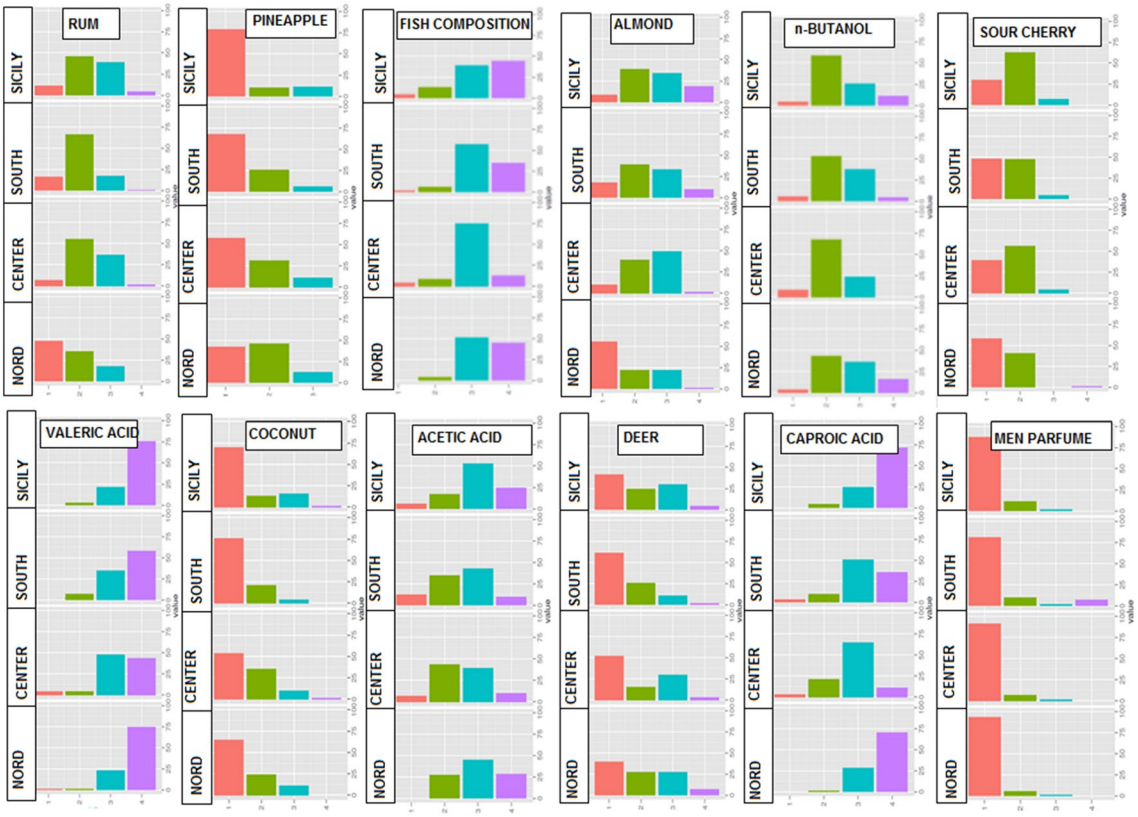


**Fig. 1** Specific hedonic tone of 12 odors who presented significant differences among regions. Possible answers were: (1) pleasant, (2) neutral, (3) unpleasant, and (4) very unpleasant

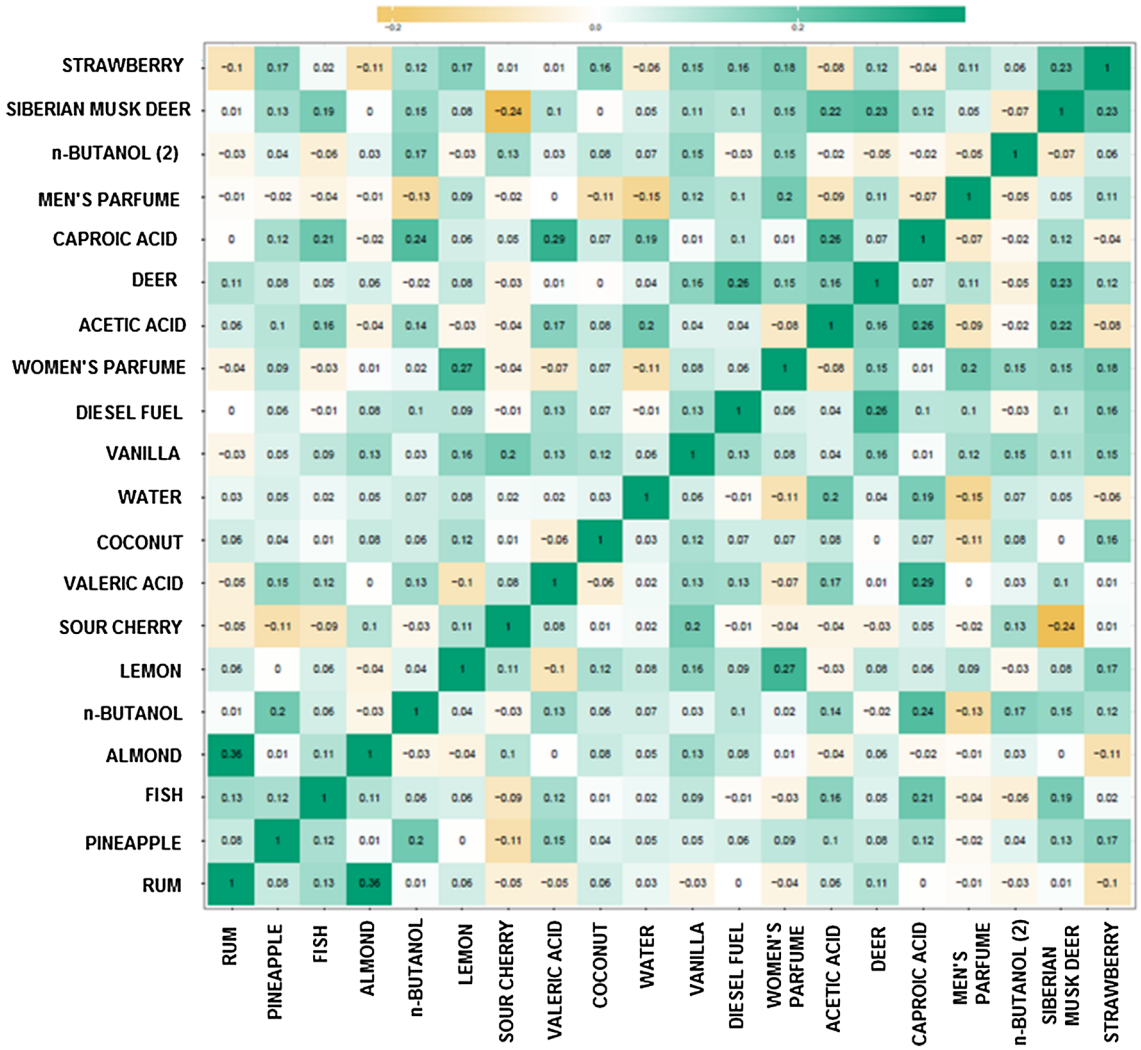


**Fig. 2** Association among pairs of odorants using Spearman coefficient. *Yellow* indicates negative association and *green* positive association between the odorants

## Discussion

Despite the extent of the medical literature on social-demographic [13] and cross-cultural differences in odor perception [5, 14, 15], no studies of the impact of regional differences on the hedonic perception of olfactory stimuli within a single major EU country have yet been published. Indeed, this is the first study to portray variations in the qualitative perception of odors across the multicultural spectrum of Italian regions. Both the pleasure perceived and the emotional state felt during olfactory stimulation seem to be related to autobiographical memories. Indeed, pleasantness and familiarity toward an odor are related to memories of the past experiences [16]. On this regard, it has been proposed that dietary flavors are transmitted in the amniotic fluid and that infants can also learn flavor cues in breast milk. The fact that infants can learn about the types of foods eaten by their mothers during pregnancy and lactation may suggest that culture-specific food preferences are likely initiated early in life, and so, some of the regional variation observed may also be influenced by regional dietary patterns [17]. Consistently, we found a significant difference in the hedonic tone elicited by rum particularly in northern Italy, where familiarity seemed to play a major role in positive judgement. Indeed, because alcohol consumption is significantly higher in this part of the country than in the other regional areas, it is possible that people, being more used to alcohol odors, tend to perceive it as more pleasant [18, 19]. Another interesting result was that the way the almond odor was perceived in Sicily. Almond is a typical Asiatic and Mediterranean fruit. It was introduced in Sicily by the Phoenicians and, since then, Sicily has been a major

almond producer. Furthermore, a number of typical Sicilian desserts, such as pastries, cookies, or marzipan sweets, are prepared with almonds. Intriguingly, we observed that almond was considered more pleasant in the north than in the rest of Italy. A possible explanation could be that Sicilians, as well as Italians from central and southern Italy, are more used to smelling the real natural odor of almonds. By contrast, the synthetic odor of almonds was considered more pleasant in northern Italy, where there is no almond production and its consumption is much lower than in the rest of Italy. Similarly, sour cherry was judged more pleasant in the north. A likely explanation for this phenomenon could be that although the production and consumption of sour cherry are fairly high in northern Italy, in particular in the Veneto region, the production of such fruit is still much higher in the south. Thus, once again, the synthetic odor of sour cherry could have been considered less pleasant in Sicily than in northern Italy. Another influential aspect to consider is lifestyle differences. In Italy, people's lifestyles are highly different between the north and the south. Industrialization is a typical phenomenon of the north and, in part, of central Italy, where people have a fast-paced lifestyle. By contrast, people from southern Italy—characterized for the most part by an agricultural based economy—have a typical "Mediterranean" lifestyle, which is characterized by a slower paced life and a much greater appreciation for fresh produce [20]. Indeed, being used to natural food flavors, our southern subjects could have more easily recognized and appreciated fresh compounds as opposed to the synthetic compounds. Pineapple was generally appreciated throughout the Italian regions. However, its odor was judged more pleasant in the south and Sicily than in the north. Such phenomenon might be explainable by the fact that the sweetness of such fruit (typical of tropical areas) was more compatible with the taste of Italians from the south than with that of Italians from the center and the north. Another possible explanation could be that the higher pineapple identification found in the south and in Sicily (Table 3) could have influenced its higher pleasantness in these regions or viceversa. Nevertheless, this was not the case with the lemon. In fact, although a great difference in the identification rates among the considered regions (Table 3), its pleasantness did not show any significant difference throughout these areas. Furthermore, analyzing the mean and SD Sniffin' Sticks identification scores, no differences could be shown among the considered Italian regions (Table 4). From the results shown in Table 4, it does not seem that a cultural adaptation of the list of Sniffin' Sticks identification subtest descriptors would be needed for different Italian regions. Anyway, to be included in the present study, the population had to show a Sniffin' Sticks identification subtest score >12. In the future, a study conducted in a larger Italian population including more regions and also hyposmic subjects could be done to see if a cultural adaptation in the list of descriptors of the Sniffin' Sticks identification subtest should be done.

Odorants, which are generally judged as unpleasant, were considered as more neutral in the center than in the rest of Italy. In fact, caproic acid, fish composition, *n*-butanol-1, valeric acid, and acetic acid were all judged less unpleasant in Rome than in the other cities. Environmental factors may well serve to explain this result. In particular, Rome is the Italian capital and the most populous city in Italy. Particulate matter components produced by traffic emission have been shown to be very high in all seasons even in indoor environments [21]. Furthermore, in large cities, the quantity of urban waste in the streets is generally higher than that in smaller cities. Therefore, it is possible that people living in Rome, being more exposed to ambient urban odors and pollution, are more used to smelling bad odors and may, therefore, find repulsive odors less unpleasant than the inhabitants of the other parts of the peninsula [6]. Intriguingly, this result was not found in a city with similar characteristics such as Naples. This discrepant result may be attributed either to the higher population of Rome being three times larger than Naples or to a different distribution of the population amongst the different districts and social groups making up the complicated socio-economic fabrics of these cities.

Concerning the associations between the different odorants tested, the strongest association was observed between almond and rum. This is the first time that an association between these odors has been demonstrated, despite being very popular ingredients of the Italian cuisine. Indeed, both almonds and rum are two staple ingredients in the traditional Italian bakery including pastries and cakes, as well as in drinks.

Another interesting association was between women's perfume and lemon. The fresh and pleasant odor of citrus fruits makes them a common ingredient of many women's perfumes and beauty products. Given the similar nature of their ingredients, an association was also observed between men's and women's perfumes. On the other hand, associations were also found between unpleasant odors. In fact, caproic acid was associated with fish composition, n-butanol-1, acetic acid, and valeric acid. Interestingly, caproic acid was associated more with *n*-butanol-1 than with *n*-butanol-2. This was probably due to the fact that *n*-butanol-1 was presented after a more neutral odor (almond) and was thus considered more unpleasant than when a more concentrated solution of the same odorant, *n*-butanol-2, was presented after a pleasant odor (men's perfume).

In conclusion, this paper establishes for the first time differences in the hedonic perception of odorants amongst different areas of the same country. Further investigation is needed to delve deeper into the influence of cultural and environmental factors on qualitative perception of odors amongst humans.

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**Compliance with ethical standards**

**Conflict of interest** Authors declare that they have no conflict of interest.

**Ethical approval** All procedures performed in studies involving human participants were in accordance with the ethical standards of the Internal Committees of the involved ENT Sections and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

**Informed consent** Informed consent was obtained from all individual participants included in the study.

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